



## Chapter Four: The Human Environment

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### Demographics

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Population densities in coastal areas in America are growing at a faster rate than that of the general population (Valiela et al., 1992). Barnstable County, according to Valiela et al. (1992), is growing faster than all of the mainland Massachusetts counties. The population density for Barnstable County, which has an area of 396 square miles, is approximately 472 people per square mile. The outer Cape, consisting of 95.1 square miles, has a population density of 284 people per square mile (Figure 4.1). Orleans has the highest population density (414 people per square mile) while Provincetown has the most densely settled population center (residential areas in or near village centers without legally defined corporate limits) with a density of 1,874 people per square mile. The 1990 Federal Census population of the towns on the outer Cape (Chatham, Eastham, Orleans, Wellfleet, Truro, Provincetown) including the Cape Cod National Seashore is 24,506, approximately 13 percent of the county's total population. The estimated summer population of the same towns increases almost five fold to 113,600 people (National Park Service, 1998). The Massachusetts Institute for Social and Economic Research (MISER) and the Cape Cod Commission estimate that by the year 2020, the off-season or winter population

of Cape Cod will increase by 23 percent and the summer population will increase by 16 percent. For the towns on the outer Cape, the Massachusetts Department of Environmental Management Office of Water Resources (1994) estimates an increase in winter population of 16.7 percent and an 11.4 percent increase in summer population.

### Roads

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Route 6 provides the north-south travel corridor on the lower Cape (Figure 4.1). These roads receive heavy amounts of traffic in the summer as they take the public from Provincetown to the upper Cape. These major routes represent the primary commercial corridor for the lower Cape, providing not only experiences for tourists but also the potential for non-point source contamination of surface and ground water. Other roads on the lower Cape that provide access to residential development are dirt roads and low use roads.

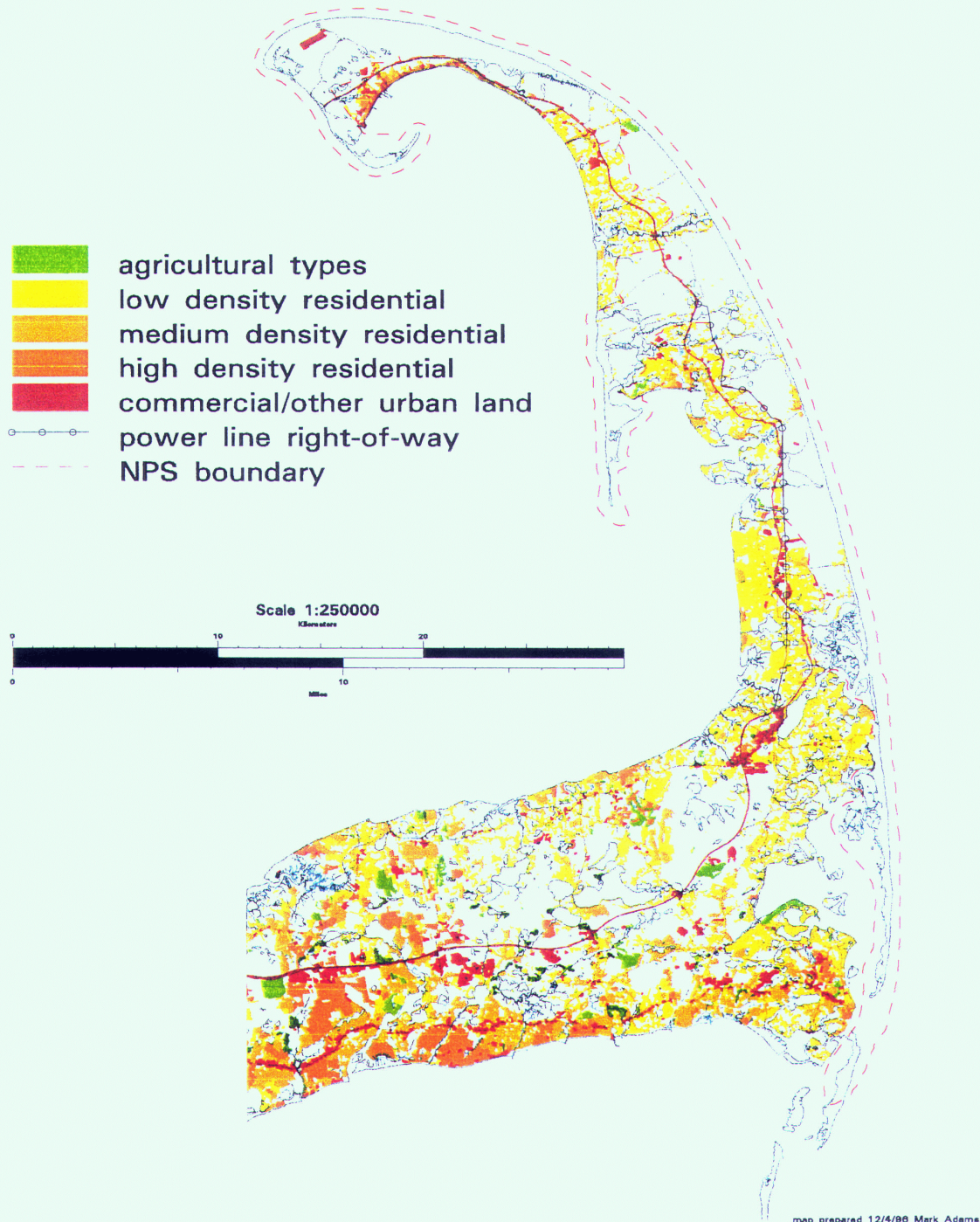
### Towns

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The National Seashore includes National Park Service lands in Eastham, Wellfleet, Truro, Provincetown, Orleans, and Chatham (Figures 1.1 and 1.2). While each town has its own set of regulations and planning tools for effective

Water Resources Management Plan  
Figure 4.1: Generalized Land Use  
Cape Cod National Seashore

Source: MassGIS, Commonwealth of Mass., 1990



implementation of water resource management plans, the Lower Cape Water Management Task Force represents the water needs and concerns of the entire lower Cape, including the National Seashore. The task force, sponsored by the Cape Cod Commission's water resource program, provides the towns, state agencies, and the National Seashore with an opportunity for multi-jurisdictional planning.

### Land Use

Land use on the Cape is commercial, residential, agricultural, and public (Figures 4.1 and 4.2). Within the boundary of the National Seashore, each outer Cape town owns varying, but small amounts of land (Table 4.1). A larger amount is held by private "improved property" owners and the Commonwealth of Massachusetts. "Improved properties" are privately owned lands and dwellings within the park boundary not subject to condemnation. While 59 percent of

the land is owned by the National Park Service, more than 30 percent within the National Seashore boundary is under the jurisdiction of other public entities, and nearly 4 percent is privately owned. The amount of upland (nontidal) acreage of each of the six communities contained in the National Seashore is shown in Table 4.1. Principal land uses within the National Seashore's boundary are conservation, recreation, rural residence, roads, a closed Air Force Base, and nine, pre-existing, private commercial uses such as gas stations and campgrounds. Each community on the outer Cape has developed zoning by-laws that comply with the Special Secretary of the Interior's zoning standards called for in PL87-126, the park's enabling legislation.

Areas adjacent to the National Seashore boundaries are generally zoned for residential development with a scattering of small-scale commercial uses. The heaviest commercial

Table 4.1. Lower Cape land area (acres) by township and within the Cape Cod National Seashore.

Township	Total	Within National Seashore (percent)	Municipal Land within National Seashore
Provincetown	6,576	5,050 (76.8)	210
Truro	14,013	9,400 (67.1)	120
Wellfleet	13,584	8,000 (58.9)	670
Eastham	10,140	3,000 (29.6)	300
Orleans	13,583	1,500 (11.0)	860
Chatham	15,660	750 (4.8)	650



**Figure 4.2a: Generalized Land Use (1990)  
Provincetown/Truro - Cape Cod National Seashore**

Source: MassGIS, Commonwealth of Massachusetts, 1990.

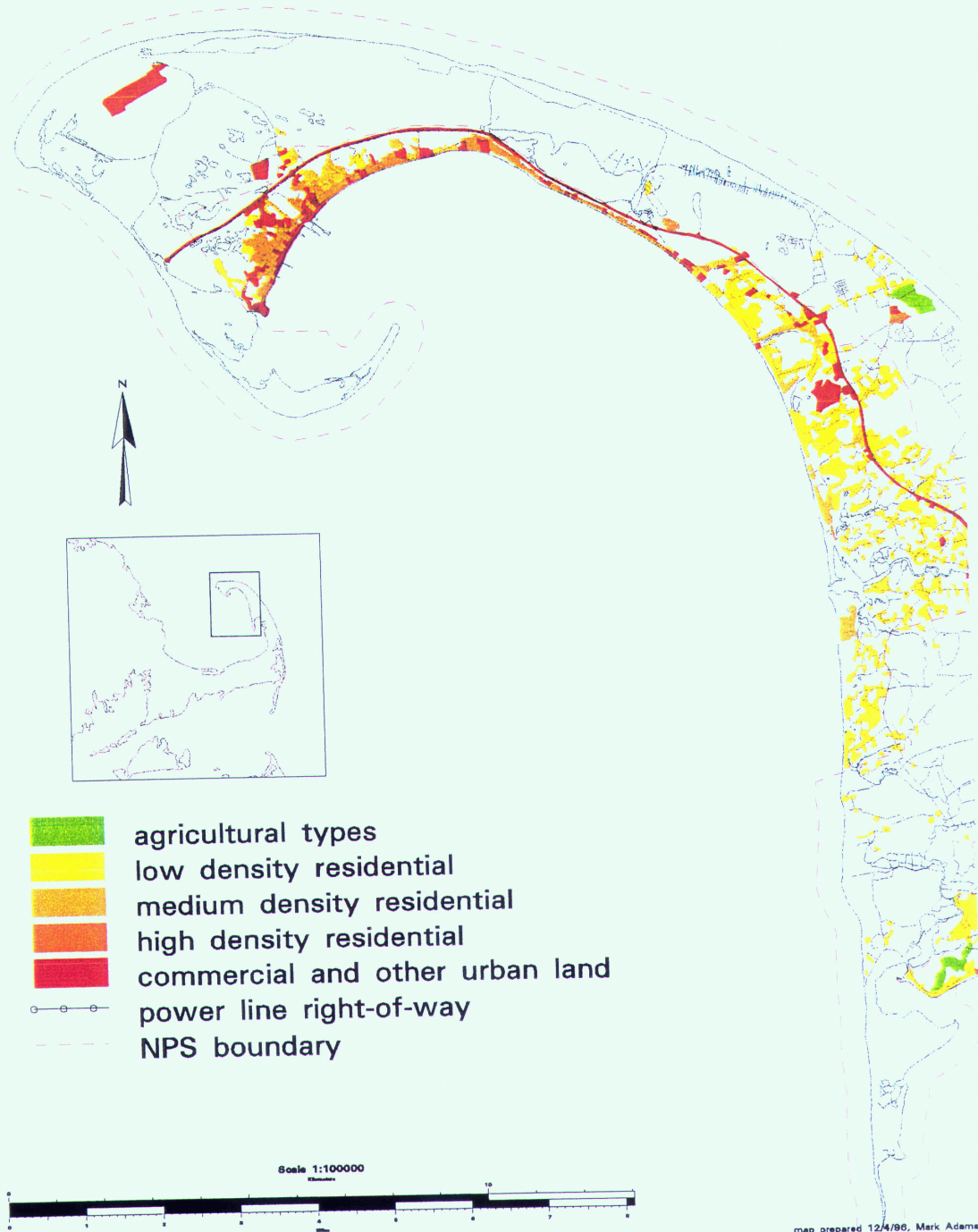
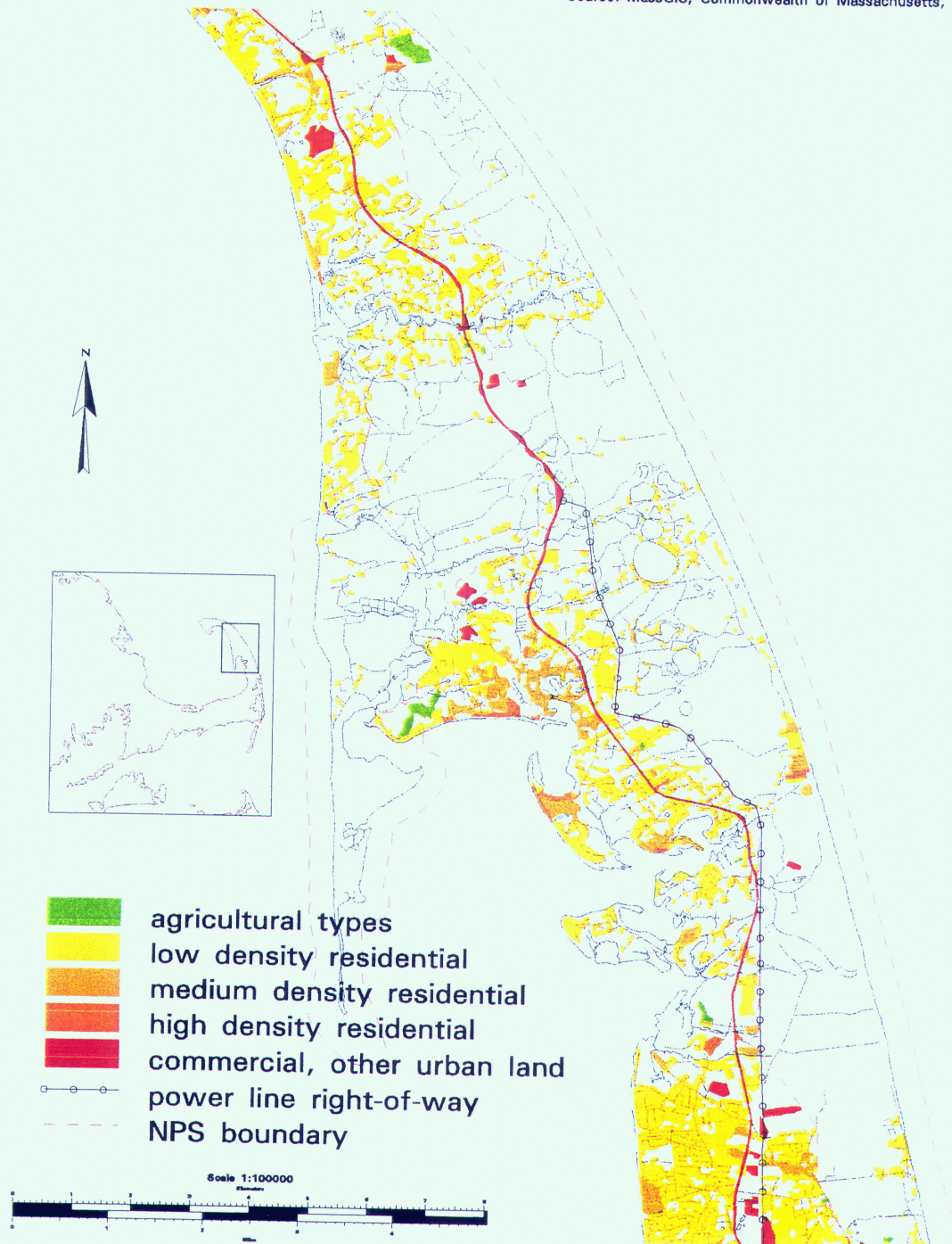




Figure 4.2b: Generalized Land Use (1990)  
Wellfleet - Cape Cod National Seashore

Source: MassGIS, Commonwealth of Massachusetts, 1990.

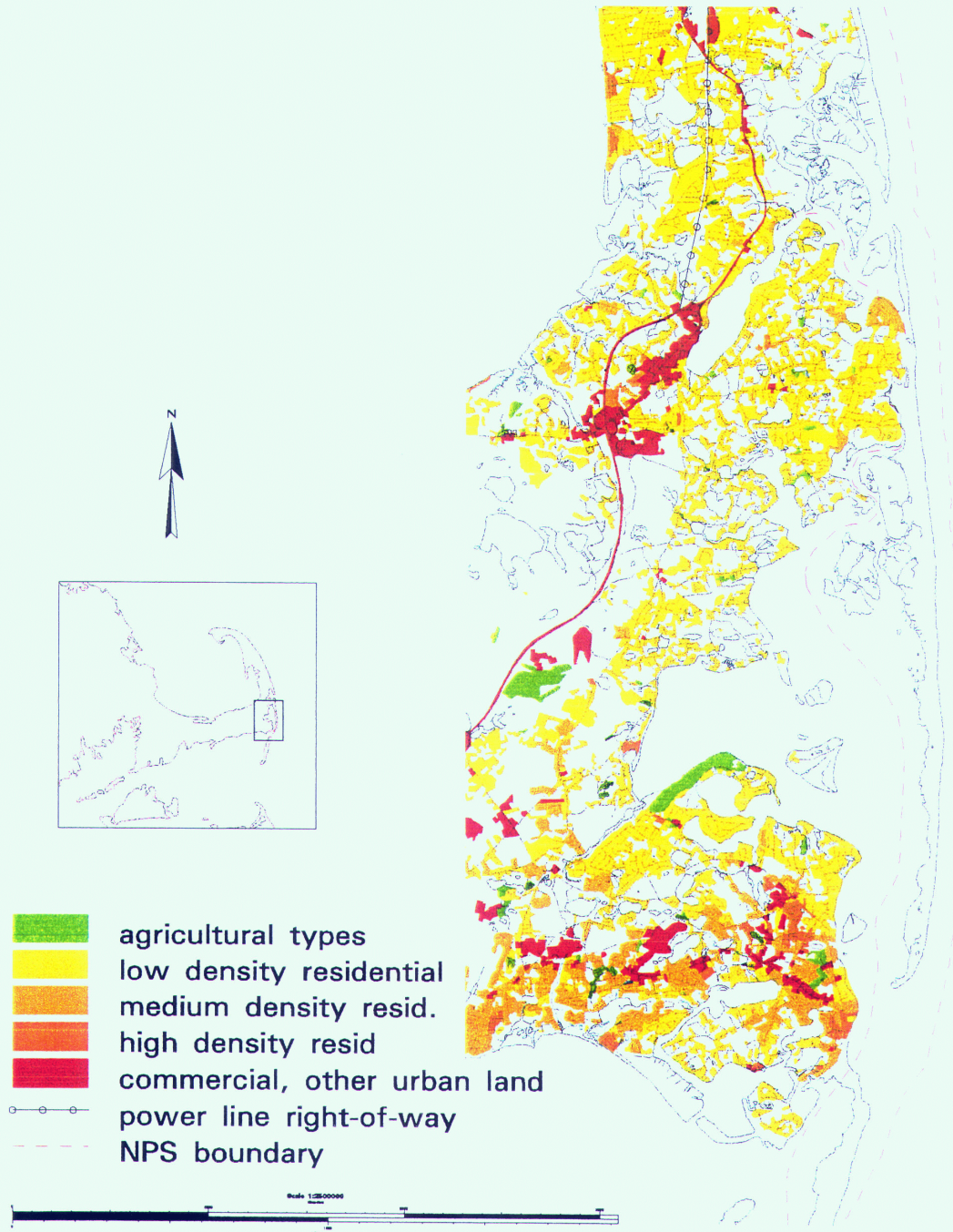


map prepared 12/4/99, Mark Adama, wrusew.am



**Figure 4.2c: Generalized Land Use (1990)  
Orleans/Chatham - Cape Cod National Seashore**

Source: MasGIS, Commonwealth of Massachusetts, 1990.



map prepared 12/4/86, Mark Adams, wrluseo.am!



and residential development along the Route 6 corridor, which bisects the National Seashore, occurs in Chatham, Orleans, Eastham, and South Wellfleet.

## **WATER USE**

### **Water Demand**

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On the lower Cape, water demand is influenced by both resident population growth and seasonal increases in visitors. In terms of maximum water usage, seasonality, not future growth of year round population, appears to have the greatest impact. Under existing conditions, average off-season and on-season demand from the Pamet lens for the towns of Provincetown and Truro are 1.65 and 6.74 MGD (million gallons per day) respectively. Summer peak demand is 9.63 MGD. Under build out conditions, off-season and on-season demand is projected to be 2.27 and 9.39 MGD with a peak summer demand of 13.45 MGD (Sobczak and Cambareri, 1995). A region is described as “built out” when all of its developable land, both residential and commercial has been developed within zoning guidelines. On the lower Cape with its limited land area, build out is an inevitable outcome of growth. Under current zoning, build out will occur outside the borders of the National Seashore and result in a greater than 50 percent increase in housing within 50 years (Sobczak and Cambareri, 1995).

### **Municipal Water Supply Locations**

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Only two of the lower Cape aquifers presently contain public water supply wells (Figure 4.3). The Coles Neck Well is a small volume well in the Chequesset lens that supplies about thirty residences in the vicinity of the Wellfleet Landfill (Sobczak and Cambareri, 1995). Two other sites in the Chequesset lens

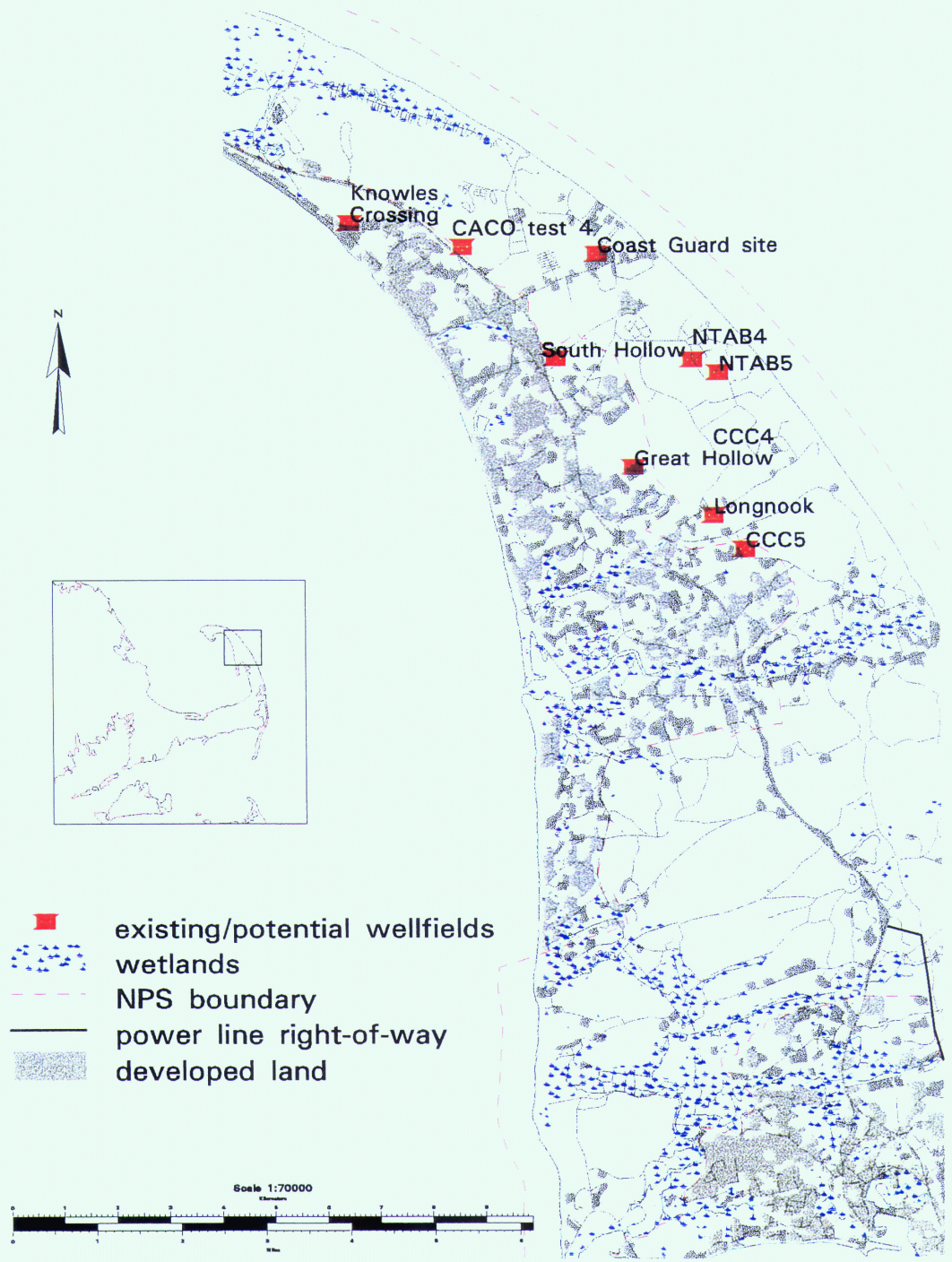
have been repeatedly mentioned as potential additional well locations. Long Nook Road (potential) is within Seashore boundaries. Estimated “safe yield” is 0.67 MGD. Mitre Site (potential) is also within National Seashore boundaries. Estimated “safe yield” is 0.8 MGD (Martin, 1993). “Safe yield” is defined as the maximum amount of water that can be withdrawn on a continual basis without inducing the intrusion of salt water into the well. Other ecological effects such as lowering the water table, dewatering wetlands, disruption of local ground water flow patterns, or decreasing freshwater discharge to surface water bodies are not considered in the definition of “safe yield” (Martin, 1993).

The Pamet lens currently supports four permanent, large volume, public water supply sites: South Hollow Wellfield (also known as Paul Daley Wellfield), Knowle’s Crossing Wellfield, and Wells #4 and #5 at the North Truro Air Force station. (Wells #1, #2, and #3 are located outside the boundary along an easement transferred to the National Park Service from the Air Force in 1998.) There is also a former public water supply site located on National Seashore property, National Seashore Test Well Site #4 (Figure 4.3). From 1908 to 1954, the main source of Provincetown water was the Knowle’s Crossing Wellfield. South Hollow Wellfield was established in 1954 because over pumping of Knowle’s Crossing had led to increasing sodium and chloride concentrations.

In July of 1978, the South Hollow Wellfield was closed after an underground gasoline tank leaked 3,000 gallons about 600 feet from the well field. The National Park Service then allowed a temporary well site to be established at Test Site #4 to be used while South Hollow was off line. Pumping also

# Water Resources Management Plan **Figure 4.3: Existing and Potential Wellfields** **Cape Cod National Seashore**

Source: NPS Water Resources Division; USFWS, National Wetlands Inventory



map prepared 12/4/95, Mark Adema, wrwell.aml



began at a site located on the North Truro Air Force Base on a year by year emergency basis. (Brenninkmeyer et al., 1987; LeBlanc, 1982; Sobczak and Cambareri, 1995). Currently, the South Hollow and Knowle's Crossing wellfields are owned by the town of Provincetown and the Air Force Base wells and Test Site #4 are owned by the National Seashore (Cambareri et al., 1989). Since 1995, when the National Seashore took ownership of the Air Force Base wells, Provincetown has retained a year by year emergency use permit of the wells.

The South Hollow Wellfield is near the center of the Pamet aquifer about 1.5 miles from the Pamet River and Pilgrim Lake - Salt Meadow area. "Safe yield" is 0.8 MGD. Withdrawals averaged 0.6 MGD from 1987 to 1991 with a peak summer demand of 0.9 MGD (Martin, 1993). Currently, there are eight, eight-inch diameter gravel pack wells in the South Hollow Wellfield that normally pump greater than 1 MGD. Due to the gasoline spill, the well field was entirely shut down from 1978 to 1980, pumped at 0.25 MGD from 1981 to 1984, and went back up to 1 MGD in 1985 to 1986 after the contamination was remediated (Cambareri et al., 1989).

The Knowles Crossing Wellfield is less than a mile south of the Salt Meadow - Pilgrim Lake area. "Safe yield" has been estimated at 0.2 MGD. Withdrawals averaged 0.085 MGD from 1987 to 1991 with peak summer demand at 0.25 MGD (Martin, 1993). Knowles Crossing consists of three gravel packed wells located very near the shore of Cape Cod Bay. It has been in operation since 1908 and has experienced high sodium levels since its inception. Prolonged pumping at rates in excess of "safe yield" (0.2 MGD) have led to periodic salt water intrusions (Cambareri et al., 1989).

National Seashore Test Site #4 is located at the bottom of a kettle, east of Route 6 and midway between South Hollow and Knowles Crossing. "Safe yield" is about 0.3 MGD. The site was used from 1979 to 1985 due to gasoline contamination at South Hollow (Martin, 1993). Use of the well was discontinued in the fall of 1986 (Cambareri et al., 1989).

There are two wells at the North Truro Air Force Base that have been used for supplemental supply to Provincetown since 1978. Combined "safe yield" is 0.57 MGD. Withdrawals have averaged 0.12 MGD from 1987 to 1991 with peak summer demand at 0.3 MGD (Martin, 1993). In 1995, the North Truro Air Force Base was deactivated and the National Seashore took ownership of the land and the wells. To date, Provincetown has been operating these wells under an emergency special use permit. No long-term (i.e., non-emergency) use of these wells is allowed under National Park Service policy (see Appendix B, 78-2).

The majority of the water from the four public well sites is used to supply Provincetown. The Provincetown Water Department services 2,200 accounts (1988), 185 of them in Truro which use 11 to 15 percent of the total water pumped on an annual basis (275 million gallons). On a seasonal basis, the Truro accounts may use up to 25 percent of the water being pumped. The public water supply main runs along Route 6A. Truro residences and businesses, located north of the Route 6A and Highland Road intersection, that experience problems with their private water supply may connect to the main provided they are within a reasonable distance (Cambareri et al., 1989).

## ENVIRONMENTAL RISK FACTORS

Non-point source pollution is a critical problem on the Cape. All of the National Seashore's water resources including ground water, ponds, marshes, and rivers are affected by various types of non-point source pollution (Portnoy, et al., 1998; Portnoy, 1994; Winkler, 1994; Noake, 1989). Most of the pollution is either organic or inorganic and caused by humans. Nutrient input to ground and surface waters from septic systems is a well documented problem on the Cape with far reaching effects to human populations and natural resources. Organic pollutants derived from landfills and leaking underground storage tanks as well as urban and septic leachate pose a serious threat to the integrity of clean drinking water supplies and natural resources. The atmospheric deposition of inorganic acids and metals to surface waters on the Cape further increases the extent of pollution impacts on all water resources. The intimate connection between ground water and surface water on the Cape compounds the difficulty of managing these problems, as does the permeability and generally poor contaminant adsorption characteristics of the sand and gravel aquifer.

The lower Cape is also largely without a sewer system, relying on private septic systems that recycle wastewater back to the ground water creating problems of nutrient

loading and nitrate contamination. Additionally, there are four inactive landfills on the lower Cape (Truro, Wellfleet, Eastham, Orleans), and one capped landfill in Provincetown. Both Provincetown and Truro landfills are located within the National Seashore boundaries and have contamination plumes emanating from their containment areas (Urish et al., 1991 and 1993; Cambareri et al., 1989; Frolich, 1991). The Wellfleet landfill abuts the National Seashore boundary and has a plume that travels southwest toward the Herring River. The effects of the five landfills are discussed in Chapter Five.

Underground storage tanks pose an additional threat to the quality of both ground and surface waters on the outer Cape. Barnstable County has a record of all active underground storage tanks in the towns surrounding the National Seashore. The majority of the tanks hold fuel oil and range in size from 200 to 2,000 gallons. Each town on the lower Cape has regulations for underground storage tanks that outlines an inspection and permitting program (Stiefel, 1996, pers. comm., Barnstable County Program Coordinator for Underground Storage Tanks). Additional details on the size and age of the underground storage tanks in Barnstable County are provided in Chapter Seven.